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Binding of Confined Vortex-Pairs in Micron-Scale, Patterned Co Films*

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ABSTRACT

Using Magnetic Force Microscopy (MFM) and Vibrating Sample Magnetometry (VSM), we have characterized the magnetic microstructures of micron-scale, Co ellipses which were patterned from Co films with thicknesses up to 70 nm. A variety of sizes and shapes (2x8, 2x4, 4x8, and 4x16 micron ellipses, and 2 and 4-micron diamater circles) show no remanant magnetization after saturation along their short axes. MFM shows that the absence of remanance results from closure domain patterns arising from the presence of vortices. Each elliptical size and shape is associated with a specific number and pattern of vortices which appear at remanance. The presence of the boundary results in demagnetization effects, which strongly favor tangential orientation of domains at the ellipse edges.

In 2x8 and 4x8 micron ellipses, two vortices with opposite circulations appear on the major axis at remanance, with their separation determined by a minimum in the potential well defined by vortex-vortex and vortex-edge interactions. Application of a magnetic field along the hard axis results in antisymmetric displacement of the vortices along the easy axis, and the vortex-vortex separation scales linearly with the applied magnetic field.

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